



Exercise : Scoring

FLUKA Beginner's Course

Exercise : Scoring

Aim of the exercise:

- 1- Learn to use scoring cards
- 2- Learn to plot simulation results
- 3- See that bin size matters
- 4- fluence or current?
- 5- topics from the hadronic lecture
- 6- statistical errors

Exercise : Scoring

- ❑ Start from the solution of example_score (copy from usb & rename) to ex_Scoring (of course in a separate subdirectory)
 - `mkdir ex_scoring ; cp $path/example_score.inp ex_Scoring/ex_Scoring.inp`
- **This input contains many examples, use them..**
- Change the beam divergence to 1900 mrad (used to see the fluence/current difference)
- Check in the input file: find the two USRBDX with current and fluence of protons arriving on target
- Add a USRTRACK to score **Fluence of photons** in the last target segment, log-E bins , unit 51, 10 keV – 10 GeV, 10 bins/decade
- Add a USRYIELD to score **photons produced in hadronic interactions** (what(4)=-1, what(5)=-2). Set it to get **lin** energy spectra. Use limits/bin size compatible with nuclear deexc photons lines ..(usually below the average binding energy, can be spaced by few keV or less). Unit 21. Careful: set 3 in what(12)
- Add a USRBIN for energy deposition, limits as the existing one, with **2mm bin size. Unit 41**
- ❑ Run 5 cycles, 1000 primaries each, process the data files

Exercise : Scoring, if you want more

- Try running with different number of primary/ cycles, and look at statistics (numbers in the `_sum.lis` and `_tab.lis` files)
- Activate the “`activ`” preprocessor directive, produce the `resnuclei` plot. Why do we need the `PHYSICS` card here? Why don't we use it normally? Look in the `.out` file to see the difference in CPU time

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- ❑ Do deposited energy and number of interactions scale with current or with fluence?
- ❑ Look in the `_sum.lis` with USRBDX protons on target: notice that fluence > current, current=1 proton/primary
- ❑ In the input with tiny divergence, it was fluence=current=1 (if you do not trust me...run the example!)
- ❑ Look in one of the `.out` files, towards the end, basic SCORE per region (can be tailored with the SCORE card). By the way, this SCORE output is good for sanity checks (...always look in the output file...). For the case with tiny divergence it was:

Region #	name	volume in cubic cm	ALL-PART Star Density Stars/cm**3 /one beam particle	BEAMPART Star Density Stars/cm**3 /one beam particle	ENERGY GeV/cm**3 /one beam particle	Density	EM-ENERGY GeV/cm**3 /one beam particle	Density
1	BLKHOLE	1.000000000D+00	0.000000000D+00	0.000000000D+00	2.925393231D+00		5.760754463D-02	
2	TARGS1	1.000000000D+00	2.100000000D-02	1.700000000D-02	3.423703213D-03		3.885211062D-04	
3	TARGS2	1.000000000D+00	3.700000000D-02	2.500000000D-02	8.068640007D-03		1.299592698D-03	
4	TARGS3	1.000000000D+00	1.648000000D+00	3.890000000D-01	4.018363464D-01		1.349091831D-01	
5	INAIR	1.000000000D+00	9.400000000D-02	8.000000000D-03	1.199892347D-02		2.625837266D-03	

- ❑ Which is the meaningful quantity if I have a “counting” detector ?
- ❑ Which one is the meaningful quantity if I have a dosimeter?

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- Plot photon fluence from unit 51. (In FLAIR, add a 1-D plot, choose the tab_lis and plot) We used log bins in order to “see” all parts of the spectrum. Notice that there are many high energy photons. Guess some of the possible sources. If you wish to check..try re-running with DISCARD.. the correct particle (advanced) . Ask yourself why there is no photon below 30KeV, and wait for the answer in the transport lecture
- Plot photon yield from unit 21: here photon lines are clearly visible. They disappeared in the USRTRACK because of interactions, which degrade the energy, and because of the coarser binning

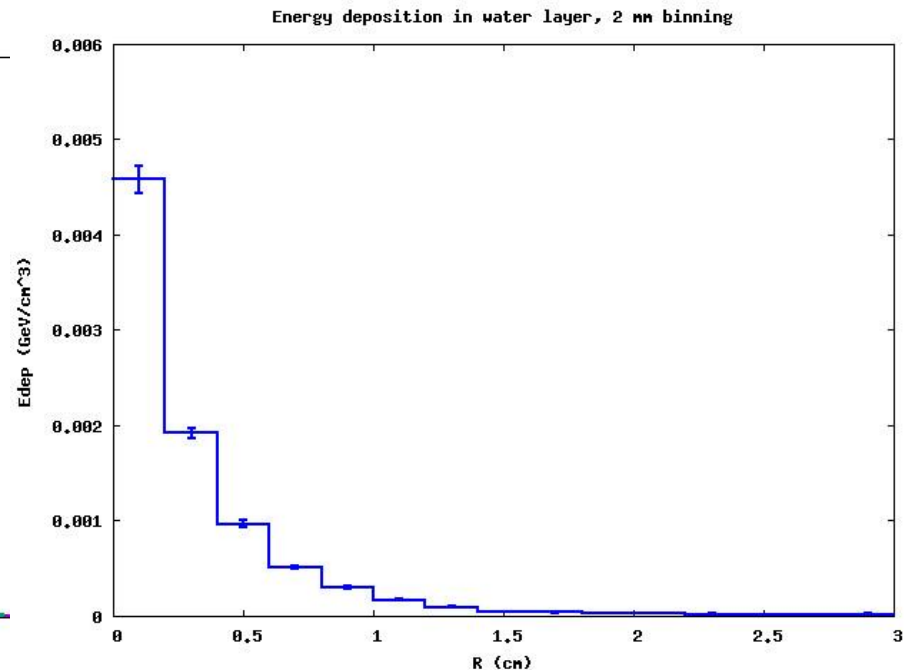
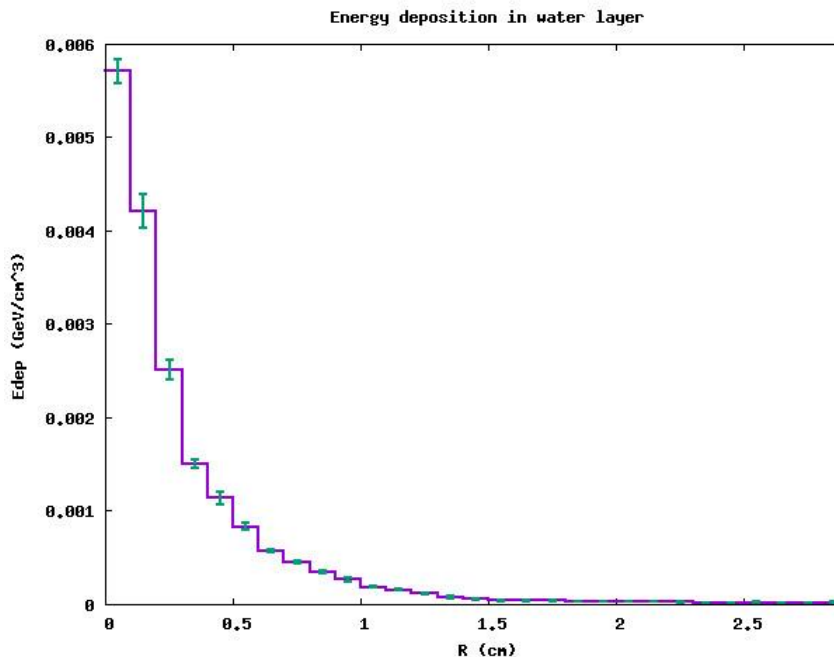
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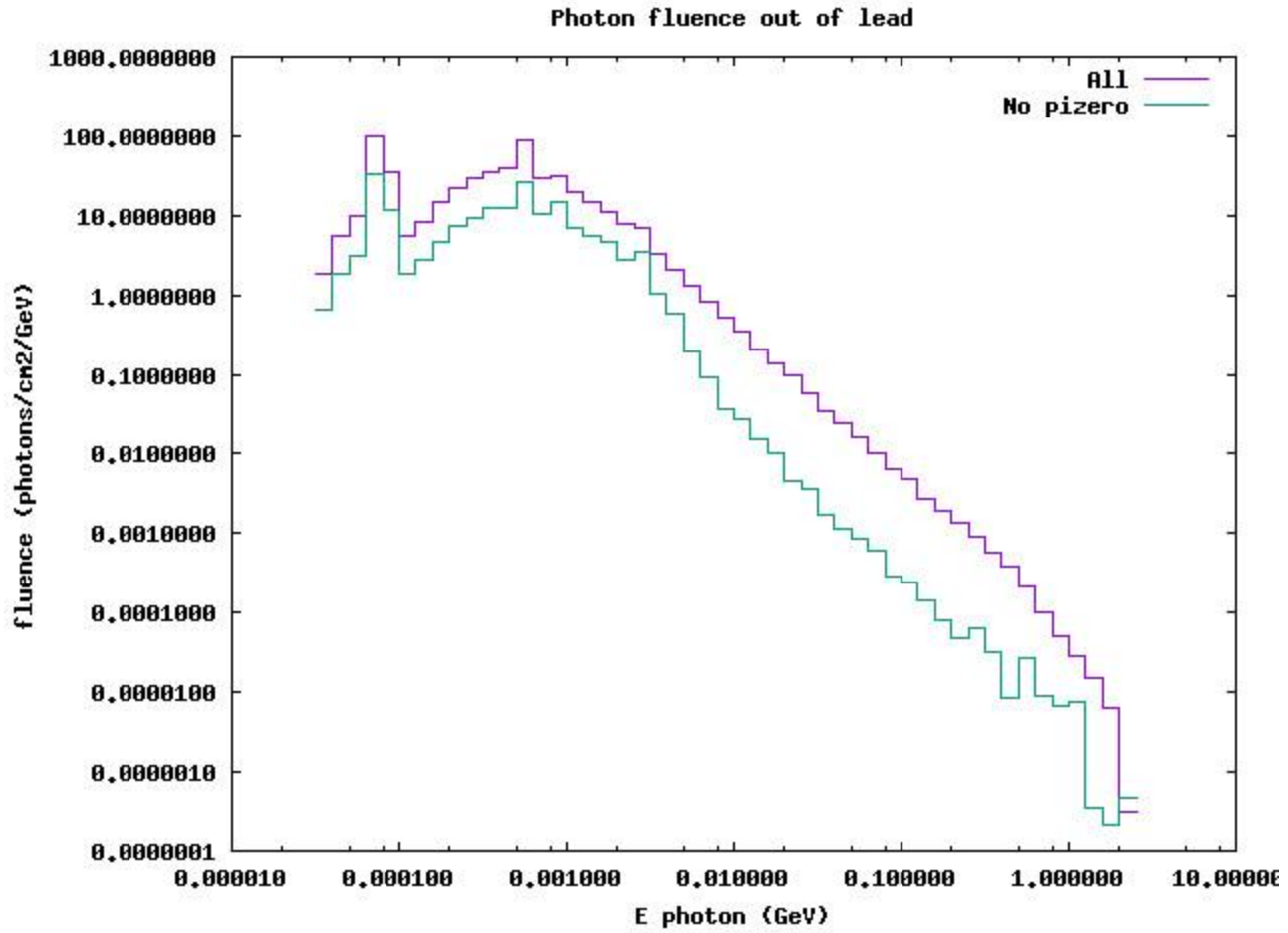
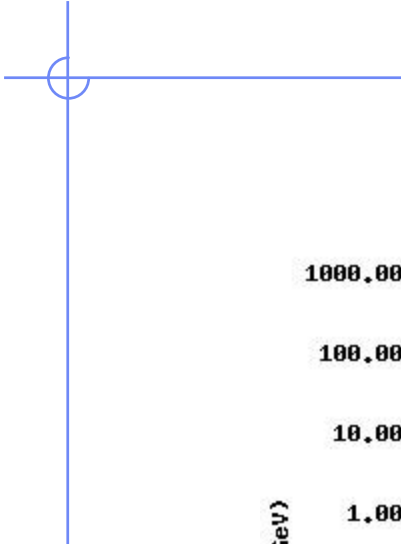
Region #	name	volume in cubic cm	ALL-PART Star Density Stars/cm**3 /one beam particle	BEAMPART Star Density Stars/cm**3 /one beam particle	ENERGY GeV/cm**3 /one beam particle	Density	EM-ENERGY GeV/cm**3 /one beam particle	Density
1	BLKHOLE	1.000000000D+00	0.000000000D+00	0.000000000D+00	3.082161475D+00		6.307162488D-02	
2	TARGS1	1.000000000D+00	2.400000000D-02	1.600000000D-02	4.561343263D-03		4.975773738D-04	
3	TARGS2	1.000000000D+00	7.100000000D-02	3.600000000D-02	1.135903757D-02		1.707459936D-03	
4	TARGS3	1.000000000D+00	1.057000000D+00	2.830000000D-01	2.780322367D-01		9.440530018D-02	
5	INATR	1.000000000D+00	8.400000000D-02	1.400000000D-02	1.191873947D-02		2.863025303D-03	
Total (integrated over volume):			1.236000000D+00	3.490000000D-01	3.388032832D+00		1.625449877D-01	

Energy in targs1 was $3.4 \cdot 10^{-3}$, now $4.5 \cdot 10^{-3}$ (with errors..) → 30% more
Fluence: was 1/primary, now 1.3/primary → 30% more

Exercise : Scoring

- Plot USBIN from unit 40 and unit 41, using
 - 1-D projection: R
 - Limit Z to water layer (0-1cm)
- Note that
 - 2mm binning gives smaller max value → be careful to bin size, without exaggerations. Depends on beam, geometry, thresholds (see lecture on ionization and transport)
 - 1mm binning has worse statistical errors (use histerror): excess in smallness means no convergence, and might be meaningless





Photons from inelastic interactions

